ISLAND NESTING OF THE GADWALL IN NORTH DAKOTA

Harold F. Duebbert

Female ducks of most species usually select nest sites widely dispersed in the available preferred habitat. However, some individual hens often nest close together forming aggregations of unusual density. Usually these aggregations are found on islands. Among diving ducks, eiders (*Somateria* spp.) and scoters (*Melanitta* spp.) are traditionally social nesters and colonies containing hundreds or thousands of nests are often formed (Gudmundson, 1932; Gross, 1944; Scott, 1951; Koskimies and Routamo, 1953; Pettingill, 1959). Scott (1952) reported high density nesting of Greater Scaup (*Aythya marila*) and Oldsquaws (*Clangula hyemalis*) on a peninsula (nearly an island) in Myvatn, a shallow lake in Iceland. Descriptions of island nesting by various species of ducks in North America, principally Gadwalls (*Anas strepera*), American Widgeon (*Mareca americana*), and Lesser Scaup (*Aythya affinis*), have been presented by Job (1898), Bent (1907, 1923), Henry (1948), Hammond and Mann (1956), and others. Clarke (1895) wrote of ducks nesting on islands in the Camargue marshes on the delta of the Rhone River in southern France. Witherby et al. (1939) noted the tendency of many species of waterfowl to select islands as nest sites.

This paper describes a study of the breeding behavior and nesting ecology of the Gadwall on an island having an extremely high nest density. Observations were made on a 7-acre natural island in Pool 320 of the Lower Souris National Wildlife Refuge in north central North Dakota, from May through August in 1956 and 1957.

In the preferred cover types on the nesting island many nests were only inches apart. At each step several hens flushed from their nests. It seemed apparent that study of Gadwall breeding behavior and nesting ecology under these crowded conditions might yield interesting results.

STUDY AREA

The Lower Souris National Wildlife Refuge consists of 58,780 acres: 21,350 acres are river bottom marsh having a freshwater ecology; uplands consist of 37,430 acres of grassland, cropland, and small tree groves. Pool 320 covers 3,600 acres; 2,700 acres (75 per cent) was in open water and 900 acres (25 per cent) in emergent aquatic vegetation, predominantly broad-leaved cattail (*Typha latifolia*) and soft-stem bulrush (*Scirpus validus*), during the years of my study. The open-water zones of the impoundment contained excellent beds of pondweeds (*Potamogeton perfoliatus, P. pectinatus,* and *P. pusillus*). Water depth in Pool 320 during the waterfowl reproduc-

tive periods of 1956 and 1957 varied from 12 to 18 inches and was relatively stable.

The natural island upon which this study was conducted (hereafter referred to as Ding Island) has gentle surface contours and was elevated 10 to 15 feet above the surrounding water levels in 1956 and 1957. It was separated from the nearest mainland by 2,000 feet of open water. A narrow fringe of emergent aquatic vegetation, predominantly soft-stem bulrush and broad-leaved cattail, surrounded most of the island. The only woody cover on the island was three small patches of low willow (*Salix* sp.) and three small box elder trees (*Acer negundo*). Figures 1 and 2 illustrate vegetative relationships and Gadwall nest locations on Ding Island in 1957.

Associations of coarse weeds, predominantly tall nettle (*Urtica procera*), and Canada thistle (*Cirsium arvense*), and giant ragweed (*Ambrosia trifida*) covered approximately 25 per cent of the island surface. The remainder was covered with a grass–forb association which included smooth brome (*Bromus inermis*), western wheatgrass (*Agropyron smithii*), quackgrass (*Agropyron repens*), bluegrass (*Poa* spp.), blue wild lettuce (*Lactuca pulchella*), flixweed (*Descurainia sophia*), goosefoot (*Chenopodium berlandieri*), sweet clover (*Melilotus* spp.), Canada anemone (*Anemone canadensis*), and prairie wild rose (*Rosa arkansana*).

Precipitation at Lower Souris during 1956 and 1957 totaled 14.94 inches and 12.09 inches, respectively. Although these amounts were less than the long-term average of 16 inches, soil moisture was adequate for full development of the vegetation on Ding Island.

The Gadwall was second in abundance among breeding ducks at Lower Souris during this study (17 per cent and 24 per cent of total breeding pairs, 1956 and 1957, respectively). In 1956 we estimated that there were approximately 1,260 breeding pairs of Gadwalls on the refuge and 450 pairs were in Pool 320. In 1957, our estimates were approximately 1,640 breeding pairs of Gadwalls on the refuge and 300 pairs were in Pool 320 (Table 1).

METHODS

An elevated blind was constructed near the island center from which Gadwall behavior could be observed. The lower portion of this blind was designed to permit temporary habitation, so that 2 or 3 days could be spent there without undue disturbance of nesting activities. A 7 × 35 binocular and 20-power spotting scope with tripod mount were used as aids to close observation.

When nesting was well advanced, the island was systematically searched with a rope drag to locate nests. They were also located by watching hens and by random walking. Tall, slender, numbered willow wands were used for

FIG. 1. Aerial view of Ding Island, Pool 320, Lower Souris National Wildlife Refuge, North Dakota, July 1957.

marking them. The stage of development of each egg was determined by use of the field candling technique of Weller (1956). Nests were visited periodically to determine their status, usually two or three times between discovery and hatching.

Plumage aberrations and other distinctive criteria made it possible to identify certain individual drakes and hens. Nest trapping of females was attempted in 1956, but it seemed to create too much disturbance and was discontinued.

Portions of vegetation surrounding three nests within 25 feet of the blind were removed in 1957, enabling me to closely observe behavior of these hens. The nearest nest was 12 feet from my blind. The height and density of vegetation supporting the highest concentration of nests prevented me from observing incubation behavior of many hens.

RESULTS

Prenesting behavior.—Gadwalls are among the last ducks to arrive on the breeding areas of the north central United States. The average spring arrival date for northern North Dakota is in the second or third week of April. Incoming migrants usually arrive in flocks of about 100 or fewer, and this

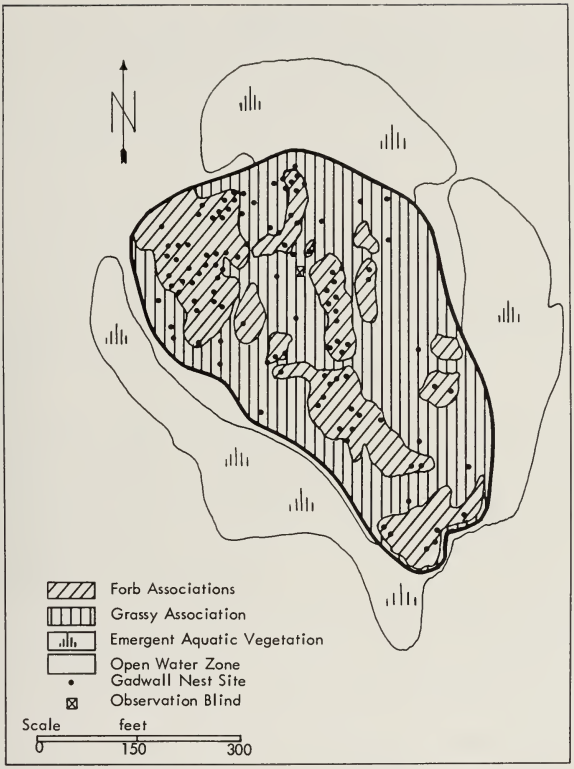

Fig. 2. Vegetative associations and Gadwall nest locations on Ding Island, 1957.

flocking pattern is maintained for 2 or 3 weeks. Upon arrival, the birds are mostly paired, and the flocks exhibit almost equal sex ratios (approximately 110 males to 100 females).

Prior to the beginning of egg laying there was little Gadwall activity near Ding Island. Gadwall pairs were assembled into flocks of five to 50 birds elsewhere in the marsh and spent their time feeding, loafing, and displaying. Water-display postures identical to those described by Lorenz (1953) were common. Most frequently observed were the "grunt–whistle," "chin-lifting," introductory shaking, displacement preening, and drinking activities.

Flocks of 30 to 100 Gadwalls frequented small open-water bays in the marsh during the prenesting period. One preferred bay was 3 miles north–northwest of Ding Island and another was 1½ miles north. On the basis of plumage variations, I was able to confirm that at least some of these pairs later moved to Ding Island to nest.

Pursuit flights composed of three to 15 birds were often initiated from

Table 1
Gadwall Populations and Production, 1956 and 1957

	1956	1957
Pairs on refuge	1,260	1,640
Broods on refuge	380	980
Productivity rate (per cent)	30	60
Pairs in Pool 320	450	300
Broods in Pool 320	135	180
Productivity rate (per cent)	30	60
Nests found on Ding Island	78	121
Broods hatched on Ding Island	60	101

these flocks on the water. Flights were often released when one pair swam too close to another pair, and I interpreted these pursuits as originating from spatial intolerance between pairs. During this period, individual distance (Conder, 1949) or moving territory (Dzubin, 1955) seemed more applicable to Gadwall behavior than territory based on topographic reference. Wüst (1960) has discussed Gadwall display flights in Bavaria; many aspects were similar to behavior observed during my study.

As the season progressed the flocks gradually dispersed. In late April and early May pairs frequented open shorelines of the impoundment 320 and adjacent broken marsh and small water areas, but many pairs occupied open-water loafing sites. Although many pairs spent long periods of time (up to 3 to 4 hours) on open water, I was not able to determine that they did not also frequent loafing sites on shorelines.

When only a few pairs were using Ding Island in early May, they spaced themselves along the shore and on the grassy zones as if maintaining discrete territories. Later, when many pairs moved to the island in late May and early June, intense aerial pursuits developed, and territoriality based on defense of a female or a section of habitat broke down. For example, on 6 June 1957, 40 pairs of Gadwalls were observed at Ding Island during the first hour after sunrise. Ten three-bird chases were seen and an additional nine flights evolved into group chases. This was typical of Gadwall breeding behavior at Ding Island during the early laying period. These flights continued to be frequent during the laying and incubation period from late May to early July. In the early morning in June and early July it was common to observe as many as 50 pursuit flights an hour from my blind.

Early in the laying period the pursuit flights seemed to originate from individual intolerance among pairs, but during incubation they appeared to be of increasing sexual significance. In nearly all pursuit flights the male of one pair chased the female of another pair; occasionally aggression was

directed toward the other male. Midair fights between males were common. Pursuit flights were especially intense during the second and third weeks of July, when the majority of hens spent most of the day on the nests and males were still sexually active. During this period male Gadwalls chased any female Gadwall in sight, even leaving the company of their own females to do so.

The combined expression of reproductive behavior by approximately 100 pairs of Gadwalls in a 7-acre area caused an intensity of pursuits not observed on the mainland. Although pursuit flights do occur among Gadwalls breeding under more dispersed conditions, they occur less frequently than under high-density nesting. Interpretation and analysis of the pursuits was difficult, because as many as 10 pursuits involving from three to 15 birds each were in progress over the island at one time during early morning in mid-June. In my opinion, the individual Gadwall pairs attempted to complete the same behavioral rhythms found in widely dispersed nesting populations. When nearly 250 Gadwalls are in approximately the same physiological condition for breeding, the resulting confusion and great variation in behavioral expression are difficult to unravel.

Although there was much aggression between the pairs, it did not prevent them from nesting successfully. This indicates that the Gadwall has evolved behavior patterns enabling many pairs to nest in a very restricted area without impairment of reproductive efficiency, a condition unusual among other ducks.

During the last week of May and the first week of June, Gadwall pairs flew into the island from its perimeter, from surrounding open water and shorelines and from marsh and pothole habitat as far as 3 miles away. Home ranges were apparently very large, consisting of several hundred acres. Pairs were very mobile and many did not favor specific sites for loafing. For example, a lone male Gadwall with a white neck ring was observed in a small bay in the marsh three miles north–northwest of Ding Island on 24 May 1957 (8:30 PM). This male was observed in the company of a female on Ding Island on 29 May (5:40 AM), while the pair was searching for a nest site. The male participated in pursuit flights at both locations.

With the high nesting density existing on this area, Gadwall home ranges were certainly much larger than the average of 67 acres described by Gates (1962). During incubation, when male harassment of lone females was very common, hens leaving their nests for the relief period flew more than a mile to feed and rest unmolested.

Nesting.—Pairs arriving on the island to scout for nest sites usually landed in the grassy zones, and after a few minutes the female walked into the weed zones while the male waited. Occasionally the male accompanied the female

during this exploration. This exploration phase preceded laying of the first egg by about 5 to 7 days.

The highest density of nests occurred in patches of nearly pure nettle; approximately 80 per cent of the nests were in this cover in 1957. Most nests were initiated when the plants were 6 to 10 inches high. By the time the majority of nests were in the late incubation stage this nettle was 5 to 6 feet high.

In 1957 six clutches of eggs were found in the bowls of Gadwall nests remaining from the preceding year. Two of these bowls appeared to have been in use for more than 2 years. Pettingill (1959) found most nests of the Common Eider (*Somateria mollissima*) in an Iceland colony were in old nest depressions.

On 6 June I dug several bowls in areas of cover near the blind where Gadwall hens had been exploring. Five eggs were found in one of these bowls on 13 June, indicating the female had laid the first egg on 9 June, just 3 days after I had made the bowl. The clutch of nine eggs was completed on 17 June and hatched on 13 July, after 26 days of incubation. This experiment suggests that the presence of a nest bowl may provide a stimulus for a hen to begin laying.

Most hens came to the island to lay between 5:00 and 7:00 AM. Ordinarily drakes accompanied the hens until the clutch was complete. The observed length of pair-bond attachment varied widely, at one extreme ending about the seventh day of laying (a hen coming in alone to lay the last three eggs of a 10-egg clutch) and at the other, lasting until the end of incubation (a drake which accompanied his female to within one day of hatching). The last date I observed a male and female together in 1957 was 12 July. Male Gadwalls had nearly all gathered into molting flocks by 1 July, and after 15 July very few males were seen.

Individual hens were well oriented to their nests–laying and incubating females flew directly to them without search or uncertainty, despite their close spacing. Hens having nests in short cover or near the edge of the dense nettle–thistle zone usually landed from three to 25 feet away and walked the remainder of the way. Hens returning to nests in the dense nettle, which was over 5 feet tall by late July, flew to a point directly over the nest and dropped within a few inches of it.

After the males had gathered into molting flocks, the nesting hens were able to carry on their daily activities unmolested. It was striking that as soon as there were no males near the island, hens flew only a short distance for their relief period, in contrast to the long flights during early incubation. On several occasions in mid-July, nesting hens gathered in groups of three to

TABLE 2
GADWALL NEST AND EGG DATA, DING ISLAND, 1956 AND 1957

	1956		1957	
	Number	Per cent	Number	Per cent
Nests found	78	——	121	——
Nests with complete history	70		109	
Hatched successfully	60	85.7	101	92.7
Predator-destroyed	7	10.0	3	2.5
Deserted by hen	3	4.3	3	2.5
Other	0	0.0	2	2.3
Totals	70	100.0	109	100.0

	1956		1957	
	Number	Per cent	Number	Per cent
Eggs studied	710	——	1,045	——
Hatched successfully	570	80.3	898	85.9
Left in nest (See Table 4)	48	6.8	66	6.2
Predator-destroyed	56	7.9	32	3.1
Deserted by hen	28	3.9	26	2.5
Unknown loss	8	1.1	6	0.7
Other	0	0.0	17	1.6
Totals	710	100.0	1,045	100.0

five just at the edge of the island to feed, bathe, and rest. This seemed to be another expression of innate sociality during the nesting season.

In 1956, 78 Gadwall nests were found on Ding Island, and a complete history was obtained for 70. I did not attempt to locate every nest but estimated that about 90 nests were present. In 1957, I attempted to locate every one and found 121 Gadwall nests: a complete history was obtained for 109. A summary of Gadwall nest and egg data obtained on Ding Island in 1956 and 1957 is presented in Table 2.

Gadwall nests situated in this nearly ideal environment had a rate of success seldom experienced by ducks nesting elsewhere. The 92.7 per cent nest success observed in 1957 may be a record for a wild nesting population of Gadwalls. Miller and Collins (1954) reported a nesting success of 90.3 per cent of 381 Gadwall nests in northern California, while Rienecker and Anderson (1960) found that 87.4 per cent of 277 nests in the same area hatched.

Average size of 51 clutches was 9.5 in 1956 and that of 79 clutches was 9.7 in 1957. In the determination of clutch size only those clutches which were being incubated when found were used. The frequency distribution of clutch sizes is shown in Table 3.

TABLE 3
CLUTCH SIZES OF 130 GADWALL NESTS UNDER INCUBATION WHEN FOUND

	Number of eggs															
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1956	1	1	5	6	8	12	9	3	3	0	0	1	0	1	0	1
1957	0	2	12	12	23	19	9	10	0	0	0	1	0	0	0	1

The only apparent hazard experienced by Gadwalls nesting in high density is a slight irregularity of daily laying and incubation rhythms. Hens attempting to lay were often chased temporarily from the island by pursuing drakes, and incubating hens returning to their nests from the daily rest period were similarly kept from their nests. A female was chased from her nest for approximately 2 hours each day for 2 days by the harassment of unattached males. Five different group pursuit flights developed around this hen as she attempted to enter her nest at the beginning of incubation. The nest hatched successfully after an incubation period of 29 days. This interruption of incubation rhythm was common among the island nesters but did not depress productivity significantly.

A few nests contained eggs of different shapes and colors, suggesting they were laid by more than one hen, although this was uncommon. For the two years, only 5 of 130 (4 per cent) known-age nests contained more than 13 eggs. In one nest of 20 eggs, 16 hatched successfully. Eggs of the Redhead (*Aythya americana*) were laid parasitically in 11 of 70 Gadwall nests (15.7 per cent) in 1956 and seven of 109 nests in 1957 (6.4 per cent). In each year Pool 320 had a breeding population of about 150 pairs of Redheads. This may account for the high rate of parasitic egg laying by the Redheads.

The condition of unhatched eggs remaining in successful nests is shown in Table 4. The group showing "no embryo developed" probably were not infertile eggs, but eggs in which embryonic death had occurred at such an early stage that an embryo was not detectable under field conditions (Munro and Kosin, 1945). It is possible that harassment of nesting females by males during early incubation caused the high early embryonic mortality observed in both years.

In 1957 one complete clutch was apparently infertile, and the female incubated this nest for at least 7 days past the normal incubation period of 26 days.

Perhaps the most remarkable aspect of the Gadwall's proclivity toward social nesting is the close spacing of nests. Many nests were found within a few feet of each other, and some were less than 12 inches apart. In the area of highest density in 1957, 28 nests were located in a 75-foot radius. This

Table 4
Condition of unhatched Eggs remaining in hatched Nests

Condition	1956 Number	1957 Number
No embryo visible	41	47
1–5-day embryo	0	0
6–10-day embryo	0	2
11–15-day embryo	3	1
16–20-day embryo	0	8
21–25-day embryo	4	7
Totals	48	66

nest density is certainly unique among surface-feeding ducks, and even among the strongly social Common Eider in Iceland, Pettingill (1959) reported that the closest nests were 2 feet apart.

The nesting period on Ding Island was relatively short, spanning a period of 7 to 9 weeks from first laying to hatching in the last nests. There was only one hatching peak in both years, indicating that renesting was not significant. In both years most eggs hatched during the period 8–14 July. First hatching occurred during the second and third weeks of June and most nests were terminated in 8 weeks. Hatching dates of mainland nests spanned more than 9 weeks in 1956 and 1957, as determined from backdated broods. In 1956 *all* eggs hatched in 41.4 per cent of the successful nests, and in 1957 *all* eggs hatched in 59.4 per cent of such nests.

Ding Island was not attractive to Gadwalls after the young had hatched. A few hens remained to brood around the perimeter of the island, but most moved their broods to other portions of Unit 320. One such favored brooding area was 300 yards northeast of the island in an open-water bay having an abundance of plant and animal foods. Some hens led their broods across about 500 yards of open water on the day they left the nest.

post-1957 conditions

That Gadwall nesting concentrations are not formed each year on a particular island irrespective of environmental conditions is shown by the following account.

On 18 June 1958, the first year after my study, the island was visited by refuge personnel and only eight active Gadwall nests were found, while 10 destroyed ones were seen. From the sign present, it was concluded that several raccoons (*Procyon lotor*) had gained access to the island because of low water levels in the unit. On 18 July, only one active Gadwall nest was found.

It was concluded that nesting Gadwall hens deserted the island either during early laying or just before laying began.

Although few observations were made in 1959, refuge personnel believed that the Gadwall nesting effort that year was low.

On 15 June 1960, 16 active Gadwall nests were found by refuge personnel on Ding Island in a 30 per cent sample of the island.

In 1961, I visited the island on 7 June and found only two active nests and destroyed nests of the Gadwall on 25 per cent of the island. It was obvious that Gadwall nesting effort was very low in 1961.

DISCUSSION

The tendency toward social nesting among Gadwall hens is most likely a traditional response to preferred environmental factors. Female Gadwalls apparently have an innate tendency to congregate for nesting, but expression of this instinct may be influenced by environmental factors. The most important factors are: (1) a small upland-type island, isolated by large expanses of open water; (2) patches of dense, coarse upland vegetation as nesting cover; and (3) absence of actual or potential predation.

Many nesting studies have revealed that Gadwalls prefer dense, coarse vegetation for nesting (Hammond and Mann, 1956; Miller and Collins, 1954; Williams and Marshall, 1938). The nettle and thistle patches on Ding Island provided an abundance of this cover type, and these weeds with the interspersed shorter vegetation provided a highly attractive nesting environment for Gadwalls.

Nest predators were very insignificant on Ding Island during this study. One family of mink (*Mustela vison*) and a few short-tailed weasels (*Mustela erminea*) were the only mammals present. Occasionally a Ring-billed Gull (*Larus delawarensis*) visited the island and some eggs were eaten by these birds, mostly from nests containing fewer than three eggs. It was obvious that predation pressure was virtually nonexistent.

Social facilitation was possibly another factor contributing to the high-density nesting. During late May and early June when most Gadwall hens in the nesting population were physiologically ready to lay eggs, aerial display behavior was at a high level of intensity over the island. It is possible that the vocal and visual stimuli provided by these displays were very stimulating to females ready to initiate nests. Such synchronization of breeding as a phenomenon among birds was first pointed out by Darling (1938) based on his study of Herring Gulls (*Larus argentatus*). In my study, small groups of nests located close to each other were often in the same stage. Also, when one hen departed from her nest for a daily rest period, nearby hens frequently left within a few minutes. These two examples suggest that the behavioral

expression of one hen may have stimulated similar behavior among other hens nearby.

Concentration of nesting Gadwalls would also be favored by a relatively high rate of homing by adult hens and return of first-year nesters to their natal area. Sowls (1955) found a high rate of homing among Gadwall hens nesting in Manitoba and Gates (1962) recorded a 60 per cent homing rate in Utah.

The interaction of the above factors during my study led to the formation of dense nesting concentrations of Gadwall hens on Ding Island. Evidence recorded in this study shows that the species does not suffer any loss of reproductive efficiency under the extreme nest density observed.

SUMMARY

An island nesting Gadwall population was studied during 1956 and 1957 at the Lower Souris National Wildlife Refuge in North Dakota. This 7-acre natural island supported extremely high nest densities in both 1956 (78 nests) and 1957 (121 nests). Vegetation supporting the highest density of nests (80 per cent of all nests) was nettle (*Urtica procera*) and Canada thistle (*Cirsium arvense*). The island was separated from the nearest mainland by 2,000 feet of open water.

In late May, pairs began moving to the nesting island and at this time much intolerance began among the pairs. The first pairs to arrive were able to maintain home ranges on the island and its shorelines. As the number of pairs increased to approximately 100, island home ranges appeared to break down and most of the pairs had at least part of their daily range up to 3 miles from the island. The intolerance between pairs seemed to have both sexual and topographic significance.

Although there was much aggression between pairs, this did not prevent normal and highly successful completion of their individual reproductive cycles.

Nesting success for the 70 nests studied in 1956 was 85.7 per cent and for the 109 nests studied in 1957, 92.7 per cent, possibly the highest success ever recorded. Causes of nest failure follow for 1956 and 1957, respectively: predation—10 per cent and 2.5 per cent; desertion—4.3 per cent and 2.5 per cent; and other causes—none and 2.3 per cent.

The average clutch size of incubated clutches was 9.5 in 1956 and 9.7 in 1957.

The nesting period was relatively short, spanning 7 to 9 weeks from first laying to last hatching. The peak hatch occurred during 8–14 July and renesting was not significant. By contrast, the mainland nesting period for Gadwalls spanned more than 9 weeks in both years.

After hatching of nests, females led their broods to other portions of the marsh for rearing.

In the 3 years following completion of this study, an interaction of low water levels and mammalian predation prevented the formation of high nesting densities on this island.

ACKNOWLEDGMENTS

Field study was financed by an Edward K. Love graduate fellowship through the Missouri Cooperative Wildlife Research Unit. Dr. W. H. Elder of the University of Missouri supervised the study. Wildlife Management Biologist M. C. Hammond, of the U.S. Fish and Wildlife Service, provided counsel during the fieldwork and reviewed

the manuscript. Refuge Manager D. V. Gray and the staff at Lower Souris Refuge aided my study in various ways. The following reviewed the manuscript: Dr. W. H. Elder; Dr. J. P. Rogers, Gaylord Memorial Laboratory, Puxico, Missouri; M. C. Hammond, Upham, North Dakota. This assistance is greatly appreciated.

LITERATURE CITED

Bent, A. C.
1907 Summer birds of southwestern Saskatchewan. *Auk*, 24:407–430.
1923 Life histories of North American wildfowl. *U.S. Natl. Mus. Bull.* 130.

Clarke, W. E.
1895 On the ornithology of the delta of the Rhone. *Ibis*, Ser. VII, I:173–211.

Conder, P. J.
1949 Individual distance. *Ibis*, 91:649–655.

Darling, F. F.
1938 Bird flocks and the breeding cycle. Cambridge University Press, London.

Dzubin, A.
1955 Some evidences of home range in waterfowl. *Trans. North Amer. Wildl. Conf.*, 20:278–298.

Gates, J. M.
1962 Breeding biology of the Gadwall in northern Utah. *Wilson Bull.*, 74:43–65.

Gudmundson, F.
1932 Observations made on Icelandic eider ducks. *Beitr. Fortpfl.-biolog.*, 8:85–93; 142–147.

Gross, A. O.
1944 The present status of the American Eider on the Maine coast. *Wilson Bull.*, 56:15–26.

Hammond, M. C., and G. E. Mann
1956 Waterfowl nesting islands. *J. Wildl. Mgmt.*, 20:345–352.

Henry, C. J.
1948 Summer on the Souris marsh. *Audubon Mag.*, 50:242–249.

Job, H. K.
1898 The enchanted isles. *Osprey*, 3:37–41.

Koskimies, J., and E. Routamo
1953 The breeding biology of the Velvet Scoter. Part I. Papers on Game Research No. 10. Game Research Institute, Helsinki.

Lorenz, K.
1953 Comparative studies on the behavior of the Anatinae. Reprinted from *Aviculture Mag.* (1941).

Miller, A. W., and B. D. Collins
1954 A nesting study of ducks and coots on Tule Lake and Lower Klamath National Wildlife refuges. *California Fish and Game*, 40:17–37.

Munro, S. S., and I. L. Kosin
1945 Proof of the existence of pre-oviposital embryonic deaths and their bearing on the relation between "fertility" and "hatchability." *Canadian J. Res.* D, 23: 129–138.

Pettingill, O. S., Jr.
1959 Puffins and eiders in Iceland. *Maine Field Nat.*, 15:58–71.

Rienecker, W. C., and W. Anderson
1960 A waterfowl nesting study on Tule Lake and Lower Klamath National Wildlife refuges. *California Fish and Game*, 46:481–506.

Scott, P.
1951 Wild geese and Eskimos. Charles Scribner's Sons, New York.
1952 Myvatn 1951. Severn Wildfowl Trust Annual Report (1951–1952), 5:125–132. Country Life Ltd., London.

Sowls, L. K.
1955 Prairie ducks—A study of their behavior, ecology and management. Stackpole Co. Harrisburg, Pa.

Weller, M. W.
1956 A simple field candler for waterfowl egg. *J. Wildl. Mgmt.*, 20:111–113.

Williams, C. S., and W. H. Marshall
1938 Duck nesting studies, Bear River Migratory Bird Refuge, Utah, 1937. *J. Wildl. Mgmt.*, 2:29–48.

Witherby, H. F., F. C. R. Jourdain, N. F. Ticehurst, and B. W. Tucker.
1939 The handbook of British birds. Vol. III. H. F. and G. Witherby Ltd., London.

Wüst, W.
1960 The problem of the display flight of ducks, especially of *Anas strepera*. *Proc. XII Inter. Ornith. Congress*, II:795–800.

MALHEUR NATIONAL WILDLIFE REFUGE, BURNS, OREGON, 12 FEBRUARY 1965